FIRST RECORD OF *APPIAS ALBINA INFUSCATA* FRUHSTORFER, 1910 (LEPIDOPTERA: PIERIDAE) FROM AUSTRALIA

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Abstract

We record the presence of *Appias albina infuscata* on the Australian mainland for the first time. A female black morph of this subspecies, otherwise endemic to Sumbawa, Indonesia, is recorded from near Darwin, Northern Territory. The specimen was recorded during the height of the summer monsoon and probably represents a vagrant that dispersed to north-western Australia facilitated by monsoonal climatic conditions (westerly trade winds) rather than by directional migration.

Observations

On 26th January 2010 a species of *Appias* was observed and photographed at close range in the town of Humpty Doo (12°34'03"S, 131°08'08"E), about 30 km ESE of Darwin, NT. The butterfly, a female, was observed for approximately 10 mins during the early afternoon (1430 h) feeding on flowers of *Micromelum minutum* (G. Forster) Wight & Arn. (Rutaceae) growing in the garden of a rural property adjacent to Edwin Creek, a tributary of the Howard River. During the observation period, the butterfly flew and fed at approximately 2.5m or more above the ground, rendering it difficult to photograph. Despite a careful watch the species was not observed again that day or during subsequent days.

Examination of digital images of the butterfly revealed several distinguishing features. The upperside (Fig. 1) was characterised by a broad black margin, with the termen narrowly edged white and the central areas greyish-white. On the fore wing, the black margin extended broadly along the costa and termen, and more narrowly along the dorsum (from tornus to postmedian area); much of the discal cell was also black, but the central and subbasal areas (from postmedian area distal to cell and median area immediately below cell to dorsum and base) were dark greyish-white. The fore wing had the termen slightly concave, and a series of up to four pale subapical spots that were enclosed by the broad black margin, the two spots between veins R_{4+5} and M_2 being the largest. On the hind wing, the black margin extended broadly along the termen, with the central and subbasal areas (from median area to base) broadly greyish-white. The underside of the fore wing (Fig. 2) was characterised by a conspicuous yellow patch in the cell, beyond which lay a broad black postmedian band that appeared to extend to the termen. The underside of the subapical area of the fore wing and underside of the hind

wing were both uniformly pale grey (the underside ground colour was noted to be pale grey during the observation period and not white as portrayed in the photo – the white colouration was probably due to reflection of light).

Discussion

We have identified the specimen as *Appias albina infuscata* Fruhstorfer, 1910 based on comparison of types of the genus *Appias* and other material held in the Natural History Museum, London (BMNH). Females of this subspecies are highly variable, but the 'wet-season form' is characterised by having very broad black margins on both wings, which on the fore wing enclose only a few faint subapical spots or sometimes no spots (Yata 1985). They also vary in colour with respect to the central and basal areas on the upperside, which may be either white (Fig. 3), yellow (Fig. 4) or almost black with some greyish-white (Fig. 5). The individual female recorded from near Darwin most closely resembles the holotype of *Appias albina ambigua* form saweloides Fruhstorfer, 1910 (Fig. 5), which is an infrasubspecific and unavailable name for *Appias albina infuscata* (Yata *et al.* 2010). This type specimen is almost entirely black and approaches the female black morph of *A. albina albina* from Sulawesi, except that it has some greyish-white scales in the central and basal areas. *Appias albina infuscata* is restricted to the island of Sumbawa, Indonesia, and has not previously been recorded from Australia. The other subspecies of *A. albina* (Boisduval, 1836) that occurs in close proximity to Australia is *A. albina ambigua* Grose-Smith, 1885, previously known under the name *A. albina micromalayana* Fruhstorfer, 1910, which is a junior subjective synonym of *A. albina ambigua* (Yata *et al.* 2010). This subspecies is recorded from eastern Java, Lombok, Sumba, Flores, Timor, Tanimbar and Wetar (type locality), but not the intervening island of Sumbawa (Yata 1985, Yata *et al.* 2010). Although females of *A. albina ambigua* are variable, and the black margins of the 'wet-season form' may be as broad as in *A. albina infuscata*, they are never almost entirely black. Our specimen from north-western Australia (Figs 1, 2) and the holotype of *A. albina ambigua* form saweloides (Fig. 5) represent a phenotype that appears to be unique to Sumbawa. This unique phenotype of *A. albina infuscata* and the similar looking black morph of *A. albina albina* from Sulawesi (see Yata *et al.* 2010, Fig. 19P) possibly have a genetic basis.

The specimen photographed near Darwin does not resemble females of *A. albina albina* (Boisduval, 1836) from northern Australia. Although females of *A. albina albina* in Australia are highly variable and are now known to exhibit sex-limited polymorphism, having three distinct colour morphs (white, yellow and intermediate), they do not possess broad black margins with greyish-white central areas on the upperside (Braby *et al.* 2010). In addition, in *A. albina albina* the black terminal band on the hind wing has its proximal edge deeply scalloped between the veins, and occasionally the band is reduced to black spots at the ends of veins, whereas in *A. albina infuscata*

Figs 1-5. Female *Appias albina infuscata*: (1-2) specimen photographed at Humpty Doo, NT, 26 January 2010, showing upperside (1) and underside (2); (3-5) variation in phenotype among 'wet-season forms' from Sumbawa, Indonesia, in the BMNH, showing white morph (3) (syntype, labelled "Sumbawa, Tambora 1897, ex coll. Fruhstorfer", "Fruhstorfer Coll. B.M. 1937-285.", "BMNH(E) #135652", SYNTYPE Appias albina infuscata Fruhstorfer, det. J.E. Chainey, 1999"), yellow morph (4) (syntype labelled similarly), and greyish-white morph (5) (holotype of *Appias albina ambigua* form saweloides Fruhstorfer, 1910, labelled "Sumbawa, H. Fruhstorfer BMNH(E) #142258, Fruhstorfer purchase BM:1937-285"). Figures 1-2 by A. Worsnop.

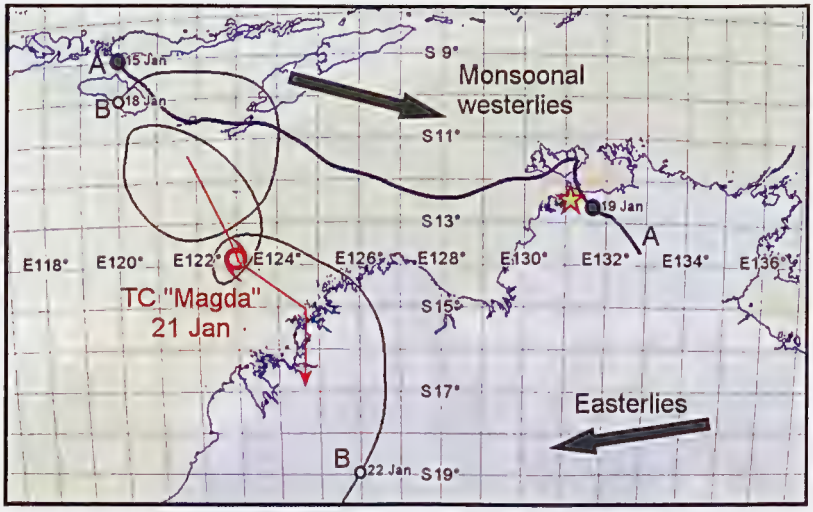

Fig. 6. Map of north-western Australia and the Lesser Sunda Islands, showing two extreme trajectories 'A' and 'B' for January 2010. Star indicates approximate location of specimen of *Appias albina infuscata* near Darwin; broad black arrows indicate prevailing wind directions during January; narrow red arrow indicates approximate path of Tropical Cyclone 'Magda'.

'wet-season form' the inner margin of the black band is relatively straight (Figs 1, 3-5). In both *A. albina albina* and *A. albina ambigua* the black terminal band on the fore wing is strongly indented between veins CuA_1 and CuA_2, whereas in *A. albina infuscata* 'wet-season form' this indentation is absent or poorly developed.

Braby *et al.* (2010) recently reviewed the distribution and habitat preferences of *A. albina albina* in northern Australia, and concluded that breeding populations of this subspecies are resident. In the Northern Territory, the nominate subspecies inhabits coastal semi-deciduous monsoon vine-thicket where its larval food plant *Drypetes deplanchei* (Brongn. & Gris) Merr. (Putranjivaceae) grows on lateritic edges and cliffs. It is considered unlikely that *A. albina infuscata* is also established in coastal areas of northern Australia; otherwise the two subspecies would be sympatric. Although *Appias* butterflies, including *A. albina*, are well-known for their ability to migrate, Darwin lies 1500 km ESE of Sumbawa, which is quite a formidable distance given the vast ocean of the Timor Sea with few 'stepping-stones' between these geographical locations. The only substantial landmasses between north-western Australia and Sumbawa that could facilitate long-distance dispersal by migration are the islands of Sumba, Flores and Timor. Hence, it is possible that the female specimen of *A. albina infuscata* was a vagrant that migrated well beyond its normal distributional range.

However, since the butterfly was recorded during the height of the summer monsoon it is also possible that the specimen was assisted by strong wind currents. The Australian summer monsoon is part of the large-scale Asian-Australian monsoon system and its arrival in northern Australia is accompanied by westerly trade winds from SE Asia (Bowman *et al.* 2010). In order to test this second hypothesis, we used the HYSPLIT trajectory model (Draxler and Hess 1998), accessed through the US 'Ready' site (Draxler and Rolph 2010). The accuracy of trajectory modelling depends to a large extent on the quality of the input meteorological analysis, but such models have been successfully used in the past to trace pollutants such as volcanic ash clouds for periods of several weeks (Tupper *et al.* 2006). The model allows for the dispersing object or gas to be released at any height above the surface. In our simulations, we chose release heights of within 500 m of mean sea level. January 2010 was an active monsoonal month, with the monsoon trough extending well south, and westerly winds across the Timor Sea. In the third week of the month, the flow regime was somewhat complicated by the formation of Tropical Cyclone 'Magda' south of Timor (Bureau of Meteorology 2010). Assuming the possibility of Sumba, Flores or Timor islands being used as stepping stones, we found several trajectories during January 2010 in which the butterfly could have reached and crossed the north-western Australian coast while staying relatively close to the surface. Figure 6 illustrates two divergent models, with trajectory 'A' (15-19 January 2010) bringing the specimen close to the area where it was found in late January in just over four days. Many similar possible trajectories to 'A' were found during the first two weeks of January. Trajectory 'B' is based on analysis from several days later (18^{th}-22^{nd} January 2010) and presents a more chaotic and overall southerly trajectory introduced to the butterfly's potential trajectory by the formation of TC 'Magda', which crossed the Kimberley on 21^{st} January 2010.

It is therefore likely that dispersal of *A. albina infuscata* across the Timor Sea from Sumbawa to north-western Australia was facilitated by monsoonal trade winds, possibly assisted by the islands of Sumba, Flores or Timor as stepping-stones, rather than by migration. Such a dispersal event would have been more possible during the first half of the month (i.e. $\leq$ 15 January 2010) than in the second half, owing to the favourable wind conditions at that time, implying that the specimen may have been on the mainland for approximately one week before it was discovered on 26^{th} January 2010.

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